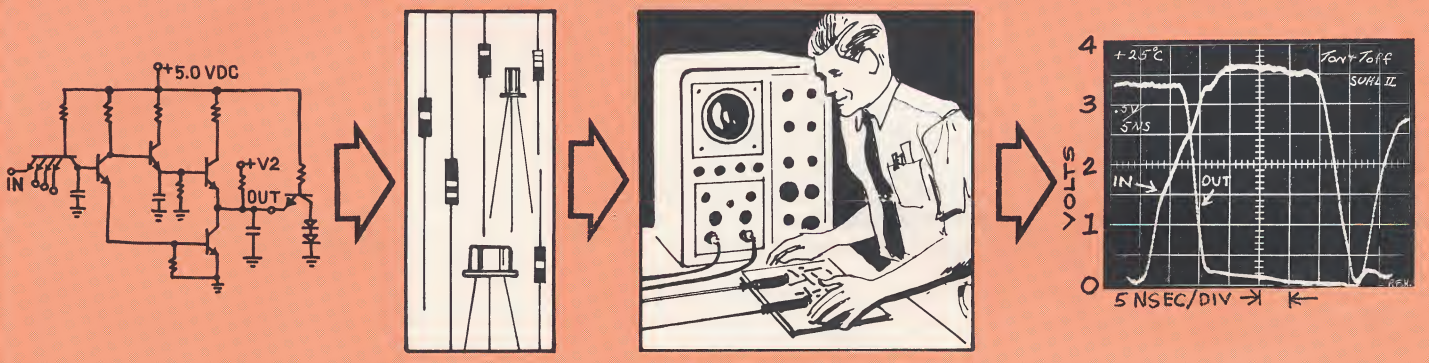
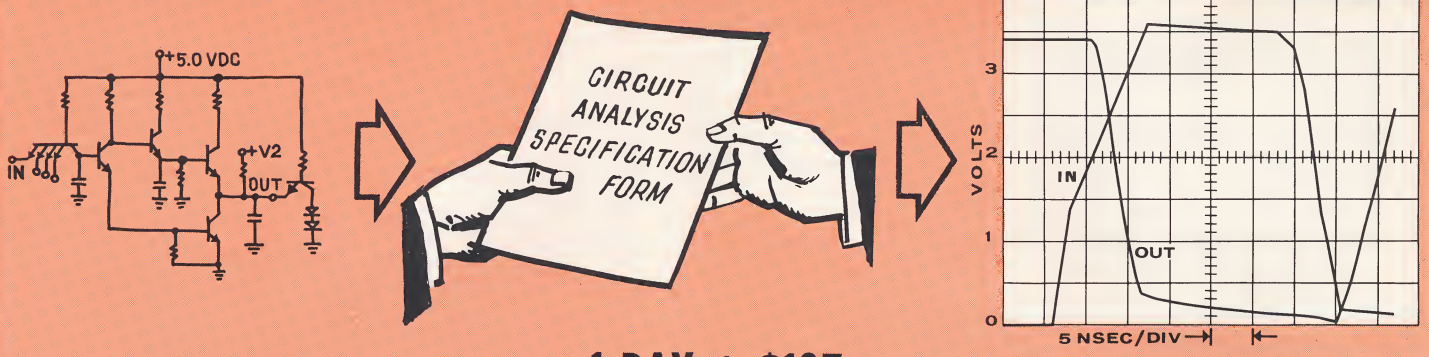
SLASH YOUR CIRCUIT DEVELOPMENT COST AND TIME

— using Design Automation's computer-programmed circuit analysis service.

TYPICAL EXAMPLE . . . test of turn-on delay, turn-off delay, and two DC transfer characteristics of discrete-component breadboard of SYLVANIA SUHL II integrated logic:



3 DAYS + $226



1 DAY + $107

- **Simulate any electronic circuit at will — discrete or integrated, linear or switching!**
- **Vary any components and semiconductor characteristics at will!**
- **Minimize expensive, slow breadboard building and testing!**
- **End accidental burn-out of costly components!**
- **No equations to work out — no computer programming to do!**
- **A faster, cheaper, more flexible method of breadboard testing — without a breadboard!**

DESIGN AUTOMATION WILL SIMULATE YOUR CIRCUITS FOR:

- Circuit design and analysis.
- Design review analysis, including component stresses, and effects of power supply failures and turn-on/turn-off sequences in all combinations.
- Failure mode analysis: short or open any component or connection and observe results.
- Evaluation of component tolerance effects.
- Tradeoff studies among conflicting performance factors and cost.
- Stronger technical proposals — include computed proof of performance of crucial new circuits.
- Value analysis, as now required on many Government contracts.

ACCEPTED BY GOVERNMENT AGENCIES

Results are ~~guaranteed~~ accurate, and have already been accepted by Government agencies for design reviews on contracts and for proof of technical claims in successful proposals.

ONE-DAY SERVICE!

DESIGN AUTOMATION, INC. / FOUR TYLER ROAD • LEXINGTON, MASSACHUSETTS 02173

How Design Automation's Circuit-Analysis Service Works . . .

We work directly from your circuit diagram — there are no circuit breadboards to build or test, and no equations to derive! We compute the steady-state DC and/or frequency and/or time response of *any* electronic circuit containing *any* combination of the components listed below — using *any* signals and component values (including semiconductor parameters) you specify.

Circuit elements accommodated

		Maximum Quantity
1. Resistors	Positive and negative values are allowed.	400
2. Capacitors		400
3. Inductors		400 if no mutuals 300 if mutuals
4. Mutual inductive couplings		11,500
5. NPN and/or PNP transistors		40 total
6. Diodes		75
7. DC voltage sources, referenced to ground or floating.		63
8. Signal sources (see below for types), referenced to ground or floating.		63
9. Linear transformers (made of inductors, mutual inductive coupling, resistors, capacitors).		—
10. Zener diodes (made of diodes, floating batteries, resistors).		—
11. Voltage-variable capacitors (reverse-biased diodes, plus bias batteries if required).		—
12. Switches, if the circuit does not contain transistors or diodes.		—
13. Special devices and effects, simulated by combinations of the above.		—

Transistor and Diode Parameters

Nominal transistor and diode parameters are supplied from Design Automation's complete library — or you can substitute your own values for any or all parameters to obtain *any* device characteristic desired. You can simulate new or costly devices not yet available for breadboard evaluation, or you can vary any device parameters — e.g. transistor gain, capacitance or cutoff frequency — to determine quantitatively their effects on circuit performance. Thirty-one parameters can be specified to provide accurate modelling of the transistor behavior, including the non-linearities and most of the departures from "ideal."

Signal sources can be any combination of:

1. DC
2. Trapezoidal, rectangular and triangular pulses, single or repetitive.
3. Step functions and ramps, with any desired rise times.
4. Gated and continuous sine waves.
5. Ramp-modulated sine waves.
6. Decaying exponentials.
7. Arbitrary waveforms, constructed from straight-line segments on a voltage-vs.-time graph.

Complete, accurate test resul print-out form

(1) All signal source voltages, (one shown).

(2) All circuit node voltages (twelve shown).

(3) All induct (two shov

```
TIME  3.70000+01     CYCLE  370

              P1
              6.0000-01

                            1            2            3           4
                         -7.6428-01   1.7687+00    4.9612+00   4.258
     1        2.3898-01   2.5000+00   2.5000+00

              L1           L2
              5.0000+00   2.5000+00

              IE           IB           IC
  T1         -3.6142+00   1.4387+00    2.1754+00
  T2          5.3564-01  -1.5505+00    1.0149+00
  T3         -3.2183+00   3.0243+00    1.9397-01
  T4         -9.2110+00   1.7989+00    7.4121+00
  T5         -6.6976+00  -2.0261+00    8.7237+00
  T6         -1.5762+00   1.6327+00   -5.6433-02
  D1          2.0754-01

  T2    SWITCHED FROM      ACTIVE        TO        OFF
  IC   ON T1 NO LONGER EXCEEDS MAXIMUM RATINGS AT TIME = 3.70
  VCB  ON T3 NO LONGER EXCEEDS MAXIMUM RATINGS AT TIME = 3.71
  IC   ON T3    EXCEEDS MAXIMUM RATING AT TIME  -      3.75000+0
```

(6) Circuit time at which any semiconductor voltage or current exceeds the device rating, the time at which it returns within the rating, and the peak excursion beyond the rating.

PRINTOUTS SHOWN HERE HALF SIZE.

Optional Spe

```
STEADY STATE SOLUTION FOR STATE    3
NODE  VOLTAGES
              1           2           3           4           5
         1.4431+00   3.8624+00   4.8209+00   4.9258+00   2.4259+00   2.100
             11          12
         2.5000+00   2.5000+00

SOURCE           VALUE        CURRENT
  V  1         5.0000+00    1.2863+01
  V  2         5.0000+00    5.1483-02
  P  1         1.3500+00   -1.1444+00
TOTAL POWER DISSIPATED= 6.30281+01
TRANSISTOR  MODE                 IE             IB           IC
  1         SATURATED        -1.14440+00    1.15965+00  -1.52471-02
  2         ACTIVE NORMAL    -1.42541+00    1.52471-02   1.41017+00
  3         ACTIVE NORMAL    -9.07251-01    1.18180-02   8.95433-01
  4         ACTIVE NORMAL    -7.52253-01    1.01005-02   7.42153-01
  5         ACTIVE NORMAL    -6.77427-01    7.53016-03   6.69896-01
  6         ACTIVE INVERTED   1.33839-01    1.14390+00  -1.27774+00
DIODE       CONDITION            I
  1         ON                1.27774+00
INDUCTOR CURRENTS
L 1   5.00000+00
L 2   2.50000+00
VCB ON T 2 IS  2.42+00 VOLTS OR  81  PERCENT OF MAXIMUM RATING
VCE ON T 2 IS  3.15+00 VOLTS OR 105  PERCENT OF MAXIMUM RATING
P   ON T 2 IS  4.46+00 MW     OR  89  PERCENT OF MAXIMUM RATING
VCE ON T 4 IS  2.50+00 VOLTS OR  83  PERCENT OF MAXIMUM RATING
VCE ON T 5 IS  2.42+00 VOLTS OR  81  PERCENT OF MAXIMUM RATING
```

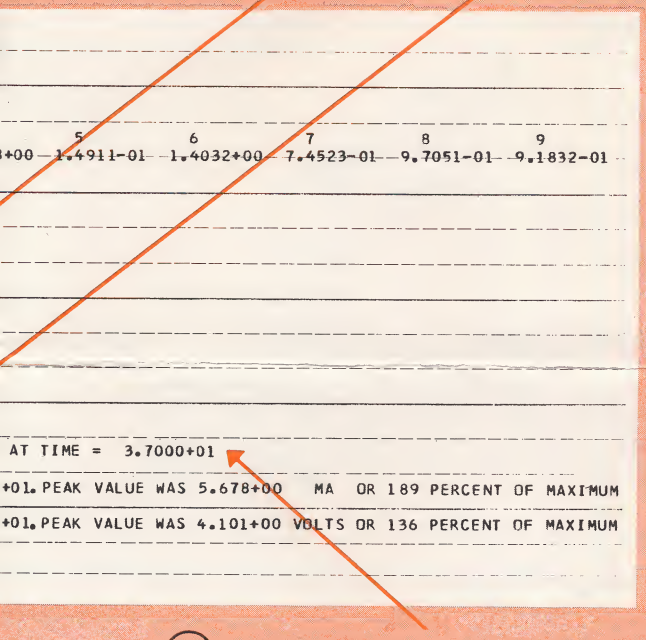
FAST ONE-DAY SERVICE, FREE MESSENGER SERV senger service is provided for pickup and delivery w between 3:00 and 5:30 P.M. to schedule a messeng can mail or deliver your problem to us. Air Mail S anywhere in the U.S.A. Computed results are normal mailed the day after receipt at our office.

ts are delivered in easy-to-read
, and include:

or currents
n).

4 All transistor emitter, base, and collector currents (six shown).

5 All diode currents (one shown).



7 Circuit time when each transistor and diode changes its operating mode, and mode identification. (Transistor modes are OFF, ACTIVE NORMAL, ACTIVE INVERTED, and SATURATED. Diode modes are ON and OFF.)

cial Features

In a single computer run of steady-state DC analysis, solutions can be obtained successively for any number of combinations of values for voltage and signal sources. This allows, for example, tracing out the DC transfer functions from any voltage source or signal source terminal to all other points in the circuit, in one computer run.

Power supply failure and turn-on/turn-off sequence analysis: for each steady-state DC analysis, each non-zero DC voltage source and signal source is grounded, individually and in all possible combinations. Transistor and diode voltages, currents and power dissipations are checked against the ratings, and any condition which causes a rating to be exceeded is identified, along with the results.

In one computer run, an analysis can be repeated automatically any number of times, changing parameter values at each repetition. This is useful in searching for the best design in a given family.

CE IN BOSTON AREA — Twice-daily free mes-
thin 15 miles of Boston. Telephone 862-8998
r pickup the following day. If you prefer, you
ecial Delivery normally arrives overnight from
delivered the day after messenger pickup, or

How Design Automation's Service pays off for YOU!

Accuracy and economy

Results are identical to those from a carefully-controlled laboratory test — but are obtained much faster and cheaper through computer simulation of circuits and components.

Ease of simulating difficult lab tests

Unlimited simulation capability enables you to perform tests that would be difficult, impossible, or destructive with actual components in a lab breadboard circuit.

Ease of achieving any combination of tolerances

You can simulate semiconductor tolerance combinations that in a normal lab test would require measuring hundreds of units to find one with a combination of parameters "close" to that desired. And you can change all component and device parameter tolerances at the stroke of a pencil, without having to tear apart and rebuild the entire breadboard.

Bypass difficult and time-consuming instrumentation problems

Measurements difficult to make on actual circuits become simple through simulation. The computer will not load the circuit or limit bandwidth. There are no problems of connecting bulky probes or current transformers to tightly-packed circuit components. Internal voltages and currents in integrated circuits are examined with ease. The computer's "current probe" response includes the DC component and has zero rise time. Signal generators will deliver the desired waveforms independent of load, duty ratio, and the inherent frustrating imperfections present in so many test equipments!

Elimination of marginal design problems

The speed, ease, and economy of computer simulation enable you to perform more exhaustive tests and design reviews — to eliminate possible "bugs" and costly marginal design problems *before* production.

You optimize designs more easily — for low cost, high performance

Find the truly "best" design faster than it formerly took to develop just a "usable" design. Ease of testing the effects of component tolerances speeds no-guesswork optimizing of designs for best performance/cost tradeoff. "Worst-case" and "statistical" evaluations of component tolerance effects are both accomplished with ease.
Using computer simulation of his circuits, the designer often gets a better understanding of his circuit operation than possible using conventional breadboard tests and paper analysis. He can observe *all* the voltages and semiconductor currents simultaneously, and can easily determine the influence of any component parameter by modifying *only* that one parameter. In a lab test with actual transistors and diodes, it is not physically possible to change only *one* desired parameter without changing all the others as well. A better-understood circuit is usually a better-designed circuit.

To have an analysis made for your circuit

Submit your circuit diagram with our Circuit Analysis Specification Form and a purchase order authorizing up to the estimated cost of the analysis, as obtained from the Price List below.

Return the enclosed reply card . . .

For further details and a supply of handy forms for specifying your circuit analysis requirements. A free two-hour orientation seminar can be arranged at your plant. If desired, check the appropriate space on the reply card.

PRICE LIST

Problem preparation:

First time a problem is run	$50.00
Subsequent runs of the same problem with new parameter values, at any future time	25.00
Computer time (see below for how to estimate)	13.50 per minute
Optional automatic repetition with parameter changes: each parameter change	2.00

No charge for messenger service for pickup and delivery at/to your office, within 15 miles of Boston. (Telephone 862-8998 between 3:00 and 5:30 P.M. to schedule a messenger pickup the following day.) FOB point for shipment outside of messenger service area is Lexington, Mass. Unless instructed otherwise, we will ship within 250 miles via First Class Mail, Special Delivery; beyond 250 miles via Air Parcel Post Special Delivery. Typical shipping weight is 5-10 lbs.

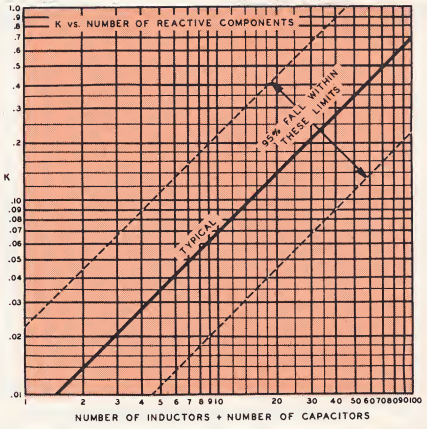
Terms are net thirty days.

HOW TO ESTIMATE COMPUTER TIME REQUIRED

Computer time required depends on the individual problem. It can be estimated as follows:

$$\text{Computer time in minutes} = 0.005\left[10 + \text{Number of components} + \text{Number of signal sources} + \text{Number of DC voltage sources} + \text{Number of semiconductor parameters changed from the library values} + 2.5\,(\text{Number of States})\right] + 0.02\left[10 + \text{Number of steady-state DC analyses}\right] + K\left[\frac{\text{Duration of Transient Analysis}}{\text{Resolution of Transient Analysis}}\right]$$

Terms used here are explained in the Circuit Analysis Specification Form.



Allow for maximum K to cover the possibility that your problem may not be "typical." Your company will be billed for computer time actually used; in most cases it will be less than the amount estimated.

Each transistor counts as two capacitors; each diode as one capacitor.

If you estimate more than ten minutes from the above formula, the time can probably be reduced substantially by slight changes in how the problem is specified, with little or no effect on the computed results.

Fill out Items 5 and 7 of the Circuit Analysis Specification Form if you wish us to make such changes.

DESIGN AUTOMATION, INC.

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PRICE LIST FOR AUTOMATED ELECTRONIC CIRCUIT ANALYSIS

Effective October 7, 1965. Supersedes list in Bulletin 5071.

Problem preparation:

First time a circuit is run . . . . . $39.00 + $2.00 per component, signal source and voltage source

Subsequent runs* of the same circuit with new connections or parameter values, at any future time . . . . . 25.00 + 2.00 per change

Optional automatic repetition with component addition, deletion or value changes . . . . . 5.00 + 2.00 per addition or value change■. No charge for deletion.

Optional conditional termination . . . . . 5.00 + 2.00 per condition

Optional graph plotting . . . . . 10.00 + 2.00 per page of plots + 2.00 per variable plotted

Computer time● . . . . . 13.50 per minute

Optional professional consultation:

Within 100 miles of Lexington, Mass. . . . . 20.00 per hour

Outside 100-mile zone . . . . . 160.00 per day or fraction thereof, plus expenses

No charge for messenger service for pickup and delivery at/to your office, within 15 miles of Boston. Telephone 862-8998 for messenger pickup.

FOB point for shipment outside of messenger service area is Lexington, Mass. Unless instructed otherwise, we will ship within 250 miles via First Class Mail Special Delivery; beyond 250 miles via Air Parcel Post Special Delivery. Typical shipping weight is 2-10 pounds.

Terms are net thirty days.

In case of error in the analysis, our liability shall be limited to repeating the analysis at no additional charge or refunding the price of the original analysis.

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*"Subsequent runs" means going back onto the computer at some later time, e.g. hours or days after the original run of that circuit. The repetitive analyses described on page 3 of Bulletin 5071 under "Optional Special Features" are "automatic repetitions" – not "subsequent runs."

■Example of pricing for optional automatic repetition: A series of DC "State" analyses contains loops within loops. V1 is stepped from 10 volts to 24 volts in steps of 2 volts. At each value of V1, V2 is stepped from 0.2 volts to 1.8 volts in steps of 0.2 volts. This double-looped example contains 72 automatically-repeated DC analyses. There are eight values of V1 and nine values of V2. One of the V1 values and one of the V2 values are considered the original circuit values, so there are fifteen changes of voltage value. Total change charge is 15 changed values at $2 each, or $30, covering all 72 DC analyses.

●See page 4 of Bulletin 5071 for how to estimate computer time for circuit analysis. Computer time for graph plotting depends on the complexity of the plot. Typical plots use on the order of 0.3 minutes to plot three variables on one page. Each circuit can generate as many pages of plots as desired. Usually up to three variables can be plotted on a page without impairing readability.

TO: DESIGN AUTOMATION, INC. Date _____

☐ Please place the following names(s) on your mailing list.

☐ Please send the following:

- ☐ Circuit analysis specification forms.
- ☐ "Transistor and Diode Models Used in Automated Circuit Analysis" (for users who want to derive their own parameter values).

☐ We are interested in having an orientation seminar at our plant.

NAME _____ TITLE _____

COMPANY _____

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CITY _____ STATE _____ ZIP _____

COMMENTS _____

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